



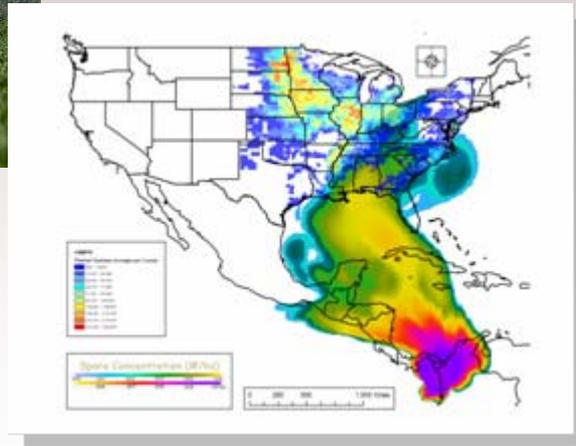
# Hyperspectral imaging for detecting the application of biochemical agents to food crops

Lori Mann Bruce, Ph.D., Daniel Reynolds, Ph.D.,  
Terrance West, Saurabh Prasad

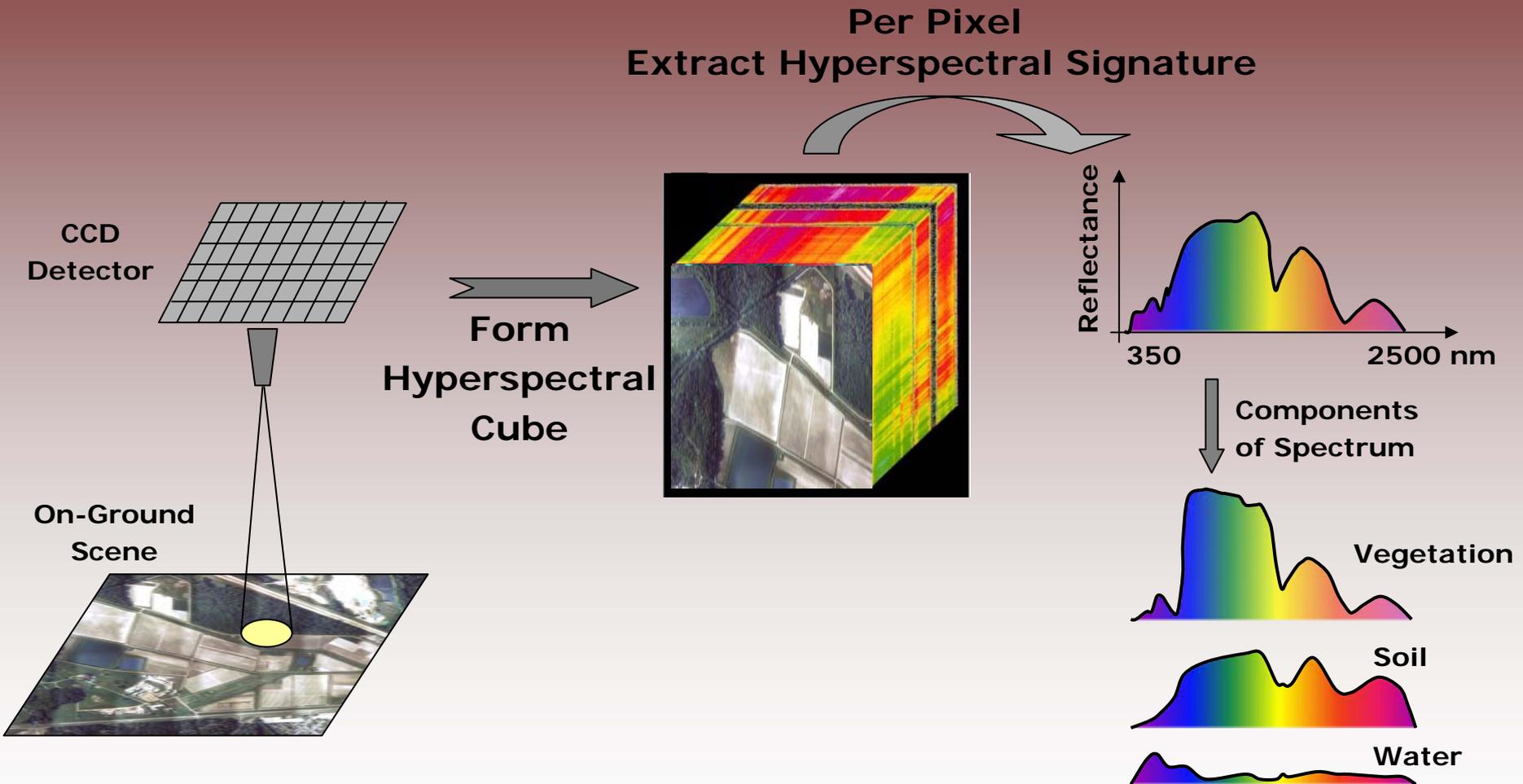
Electrical and Computer Engineering Department  
Plant and Soil Science Department  
GeoResources Institute

# Food Crop Security

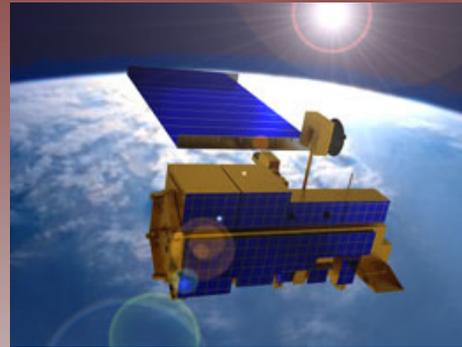
- Farm Level
- Natural Disasters
- Intentional Harm
- Hoaxes



# Hyperspectral Remote Sensing



# Hyperspectral Remote Sensing



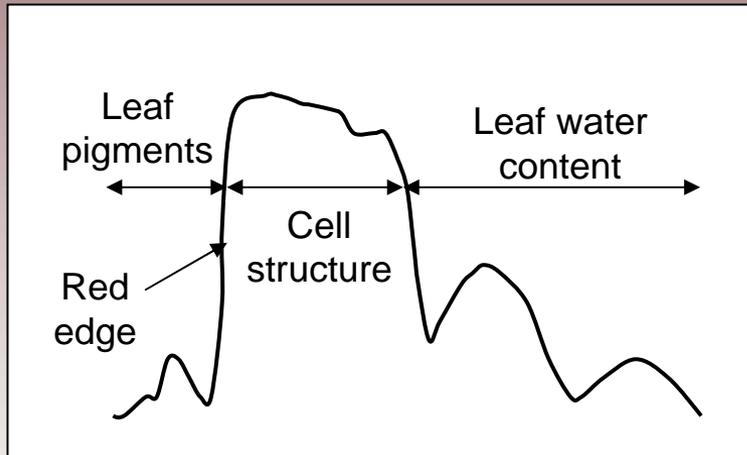
*Satellite*



*Airborne*



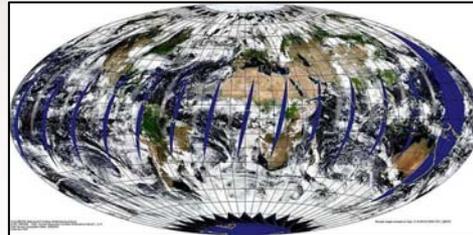
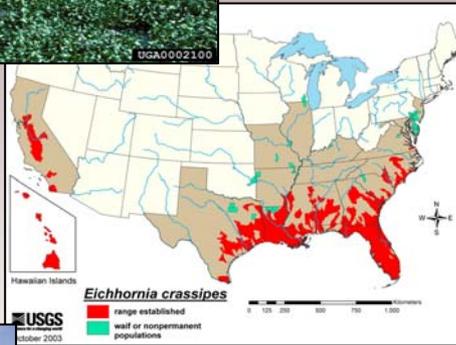
*On-Ground*



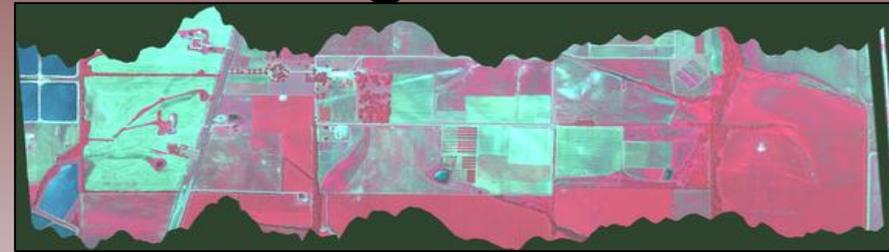
*Vegetation Analysis*

# Hyperspectral Remote Sensing

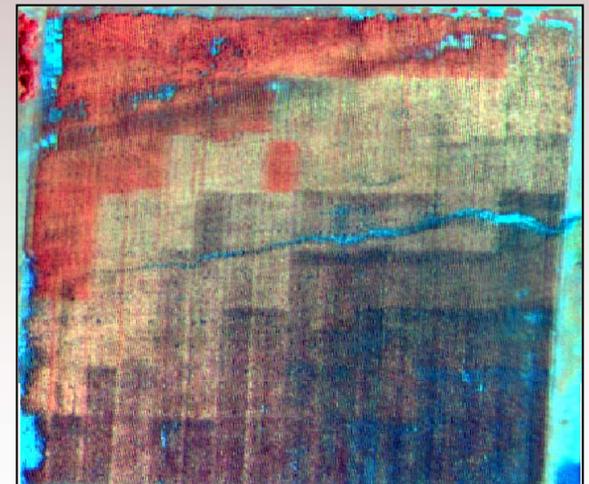
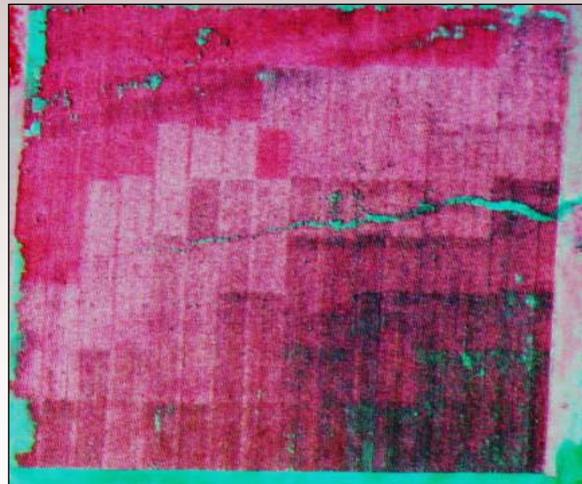
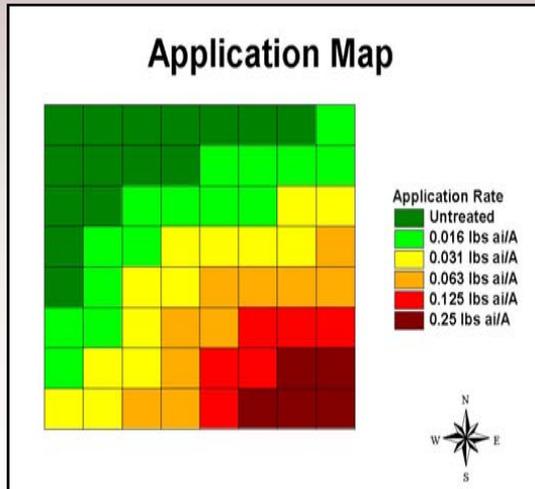
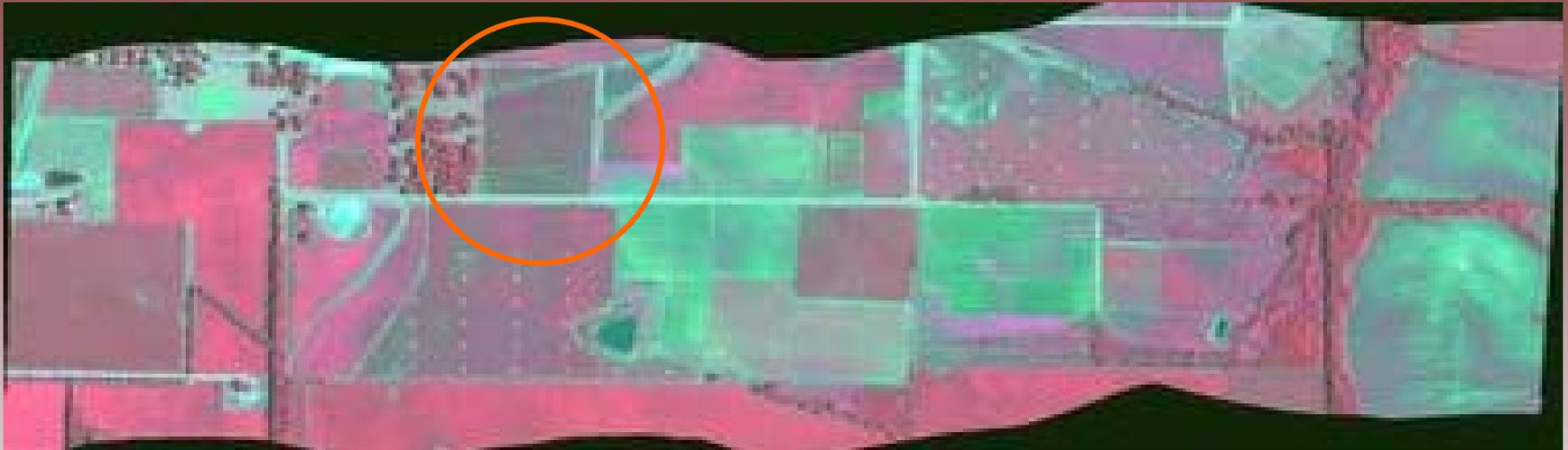
## Invasive Species Detection and Tracking



## Precision Agriculture

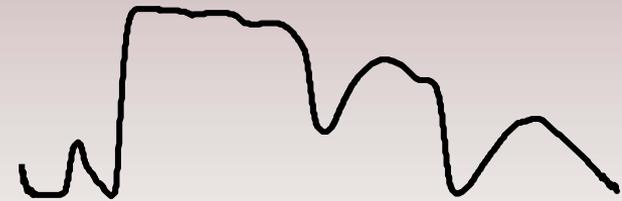
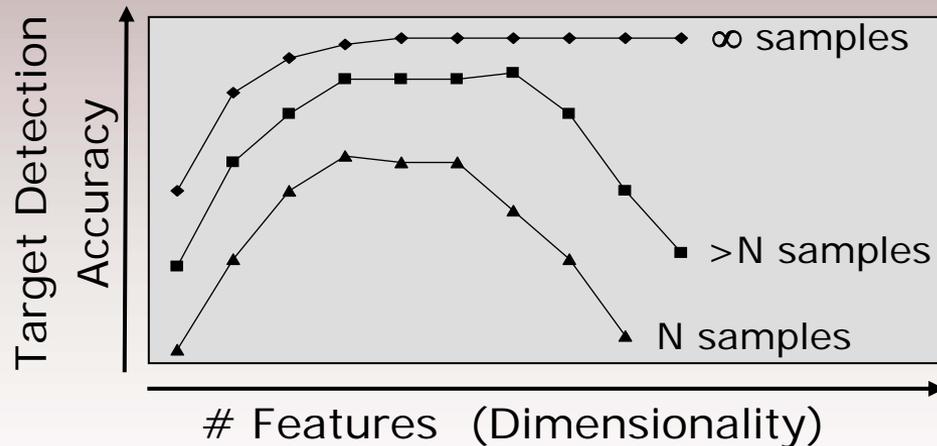


# Hyperspectral Remote Sensing



# Challenges with Hyperspectral Imaging

- Spatial Resolution
- Over-Dimensionality of Data
  - Hughes Phenomenon



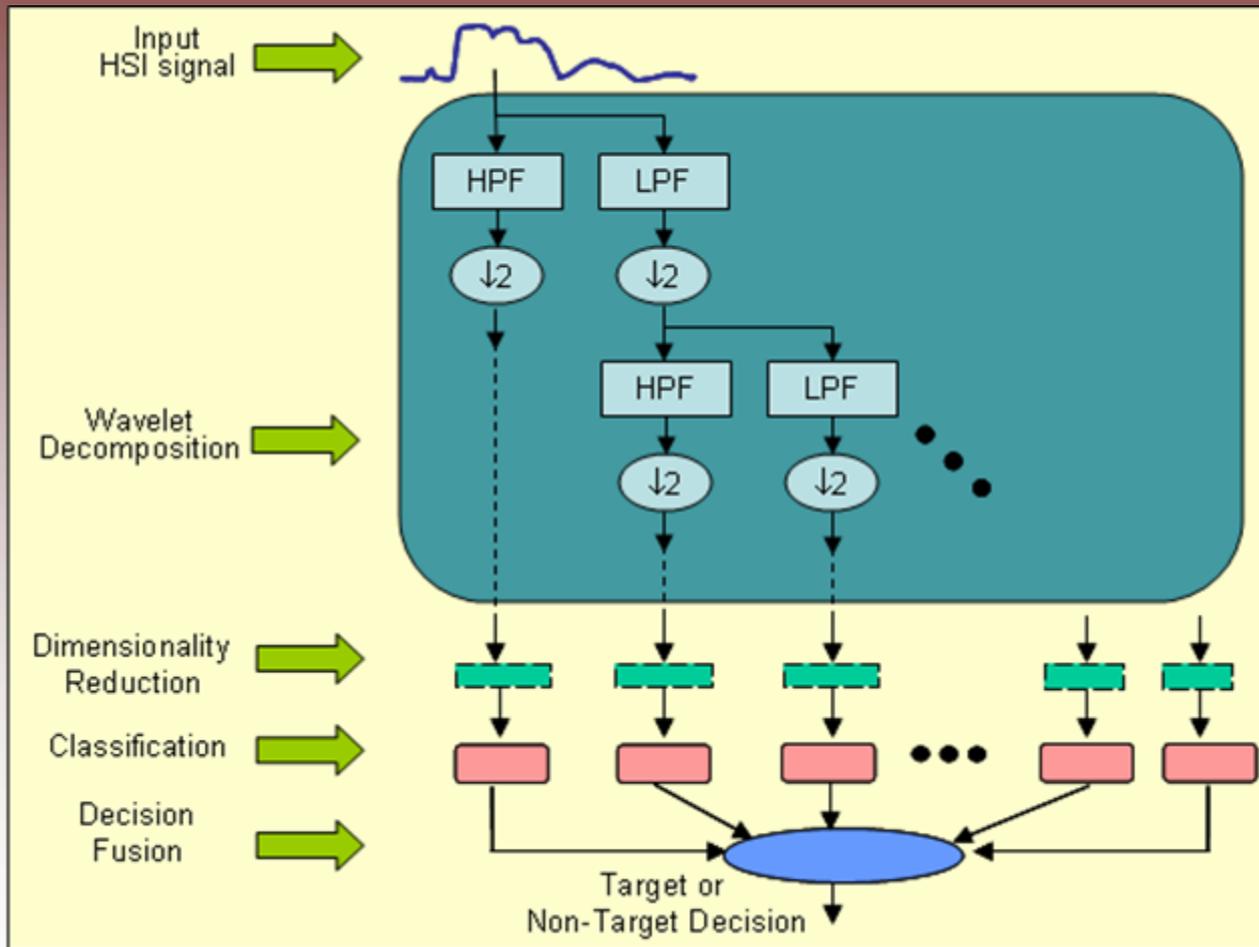
How do we decide what to use?

# Challenges – Potential Solutions

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- Feature Extraction
  - Dimensionality Reduction
- 
- Principal Component Analysis
  - Band Averaging
  - Linear Discriminant Analysis
    - Wavelet-Based Feature Extraction
    - Adaptive Band Grouping
    - Projection Pursuits

# ATR System Design



Why Wavelets?

Why  
Multi-Classifiers &  
Decision Fusion?

# Validation Studies

1. Evaluate the use of HSI for glyphosate, glufosinate, paraquat, and pyriithiobac detection in non-transgenic corn.

2. Evaluate the use of HSI for glyphosate, glufosinate, and paraquat detection in non-herbicide tolerant wheat.

3. Evaluate the use of HSI for detecting glyphosate application on non-herbicide tolerant corn and wheat in field scale systems.

4. Evaluate the use of HSI for detecting soybean rust presence in soybean crops.

Industrial Toxic  
Chemicals

Greenhouse and  
Field Studies

Airborne Disease

Greenhouse  
Studies

# *Validation and Verification*

## **Control vs. Treatment**

- Greenhouse Studies
- Field Studies (ground truth)

## **Comparison Studies**

- PCA, SLDA, Wavelets,  
Band Grouping w/ Decision Fusion

## **Assessment**

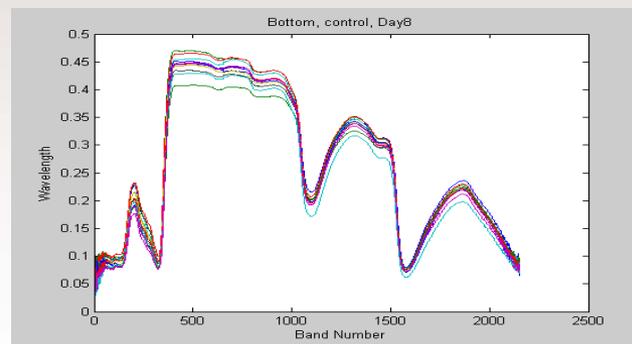
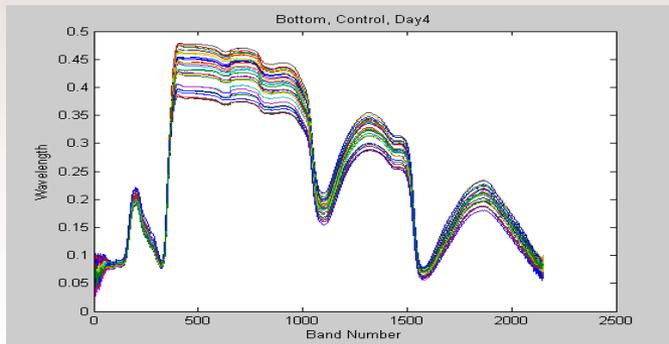
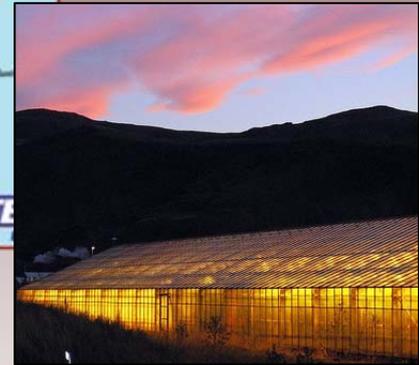
- Target Detection Accuracies
- False Alarm Rates
- Producer & User Accuracies
- Paired t-Tests



# Preliminary Results (Soybean Rust)

Soybean Rust

Devastation in 13 Days

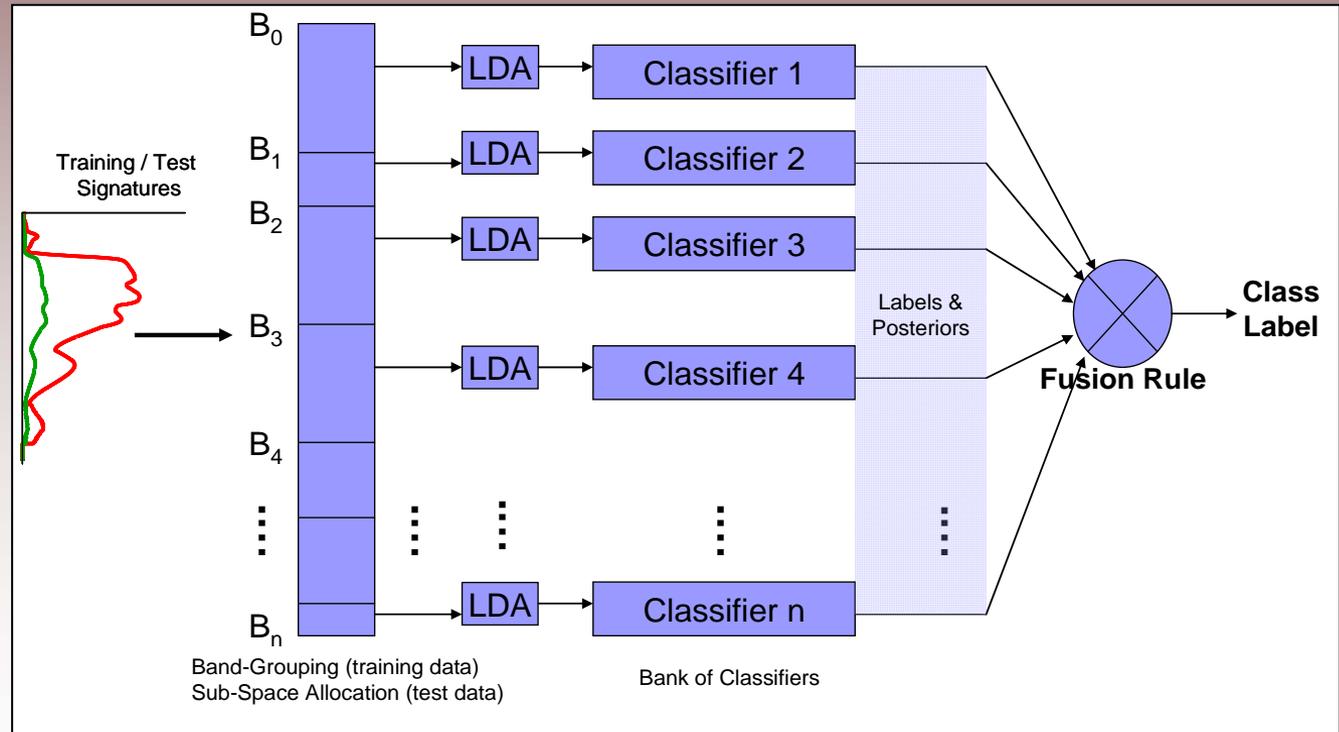


# Preliminary Results (Soybean Rust)

## Analysis I

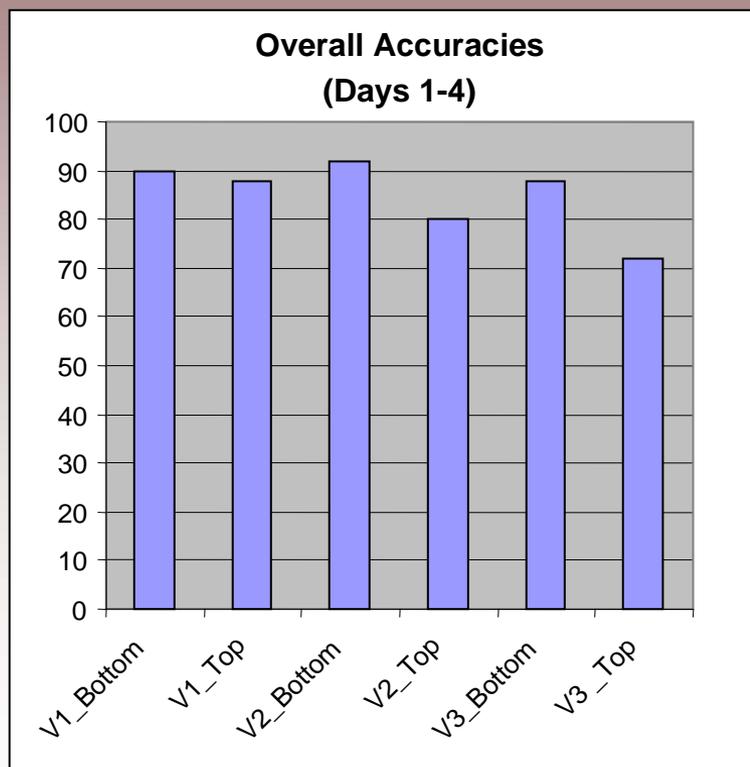
Feature Reduction/Optimization – SLDA  
Classification – Maximum Likelihood  
Testing – N-fold Cross Validation

## Analysis II

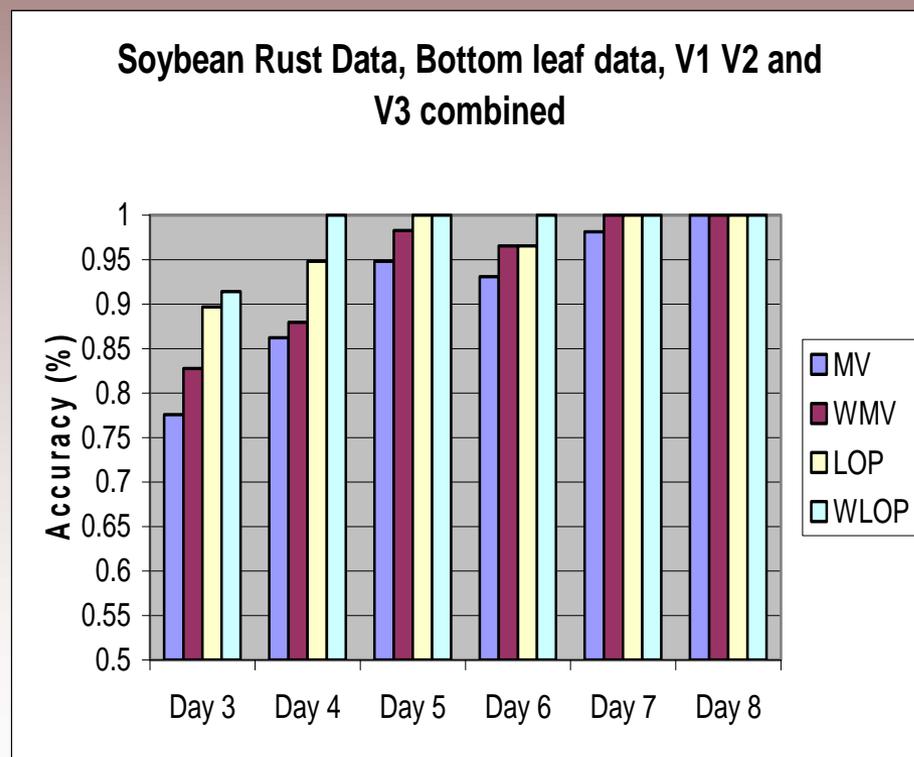


# Preliminary Results

## Analysis I



## Analysis II



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# *Thank You*



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